

Polyurethane Sponge

Equivalence between cellulose and polyurethane sponges



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1. Context

A polyurethane foam sponge (PFS) is a synthetic sponge produced in batches of open-topped molds.

A great advantage of PFS is its flexibility and its high tensile strength, making it less susceptible to flaking and tearing during environmental sample collection. Therefore, surfaces, including those that are rough and irregular, can be rigorously scrubbed during sample collection without concern that the sponge could deteriorate.

In addition, the polyurethane industry is one of the few industries with virtually no production waste, thus decreasing the ecological footprint. Indeed, trims (or waste foam from cutting operations) are re-used to produce new products, such as carpet underlay or bonded foam.

In light of such advantages, Hygiena has sourced and is now offering a synthetic sponge which has been thoroughly validated and represents an alternative to cellulose sponge.

2. Objective

To confirm that polyurethane and cellulose sponges offer similar performance.

3. Methodology

Both polyurethane and cellulose sponges are evaluated to ensure that they meet or exceed the industry standard. The evaluated characteristics are the following:

3.1. Visual inspection

Statistically representative sampling is performed for each batch. A visual inspection for minor, major and critical defects is carried out. Destructive tests such as surface scrubbing and water immersion are conducted to validate the sponge's functional performance.

3.2. pH

Ten sponges are hydrated with 10 mL of tap water and are kept at room temperature. Ten milliliters of collected tap water is also kept at room temperature and used as a control. After 30 minutes, the pH of both samples and control is measured and compared.

Interpretation of results: the pH ratio of each sponge and pH of water is calculated. The pH ratio of test sponge vs water must be between 0.89 and 1.10.

If the ratio is outside that range, the batch is rejected.

3.3. Bioburden

The bioburden of 10 samples per batch is determined to confirm sterilization effectiveness. Thus, any batch exceeding bioburden tolerance is rejected.

Bioburden tolerance:

- Average: 2 fungi per sponge
- Average: 200 CFU per sponge

3.4. Performance

Thirty two (32) sponges per batch are hydrated with 10mL of DE broth and sterilized by gamma irradiation. The performance of sterilized sponges is verified following the environmental test described by Claveau et al. (J. AOAC Int. 97, 1127-1136) with some modifications. This test's aim is to mimic industrial environmental testing. Thus, stainless steel surfaces (100 cm²) are inoculated with *Listeria monocytogenes*. The strain is exposed to dehydration stress over 18-20h. Sponges, hydrated with DE solution, are used to recover bacteria (*L. monocytogenes*). They are placed in a sterile bag with enrichment medium and are enriched for 20 ± 2h. Finally, the enrichment is plated and followed by bacterial count. Performance of sponges is evaluated based on expected recovery results. Sponges with good performance must show a viable count higher than 1x10⁶ CFU/mL after enrichment.

The test is performed using sponges with and without biocides as positive and negative controls respectively.

4. Results and discussion

Every sponge lot is lab tested. The goal of this evaluation is ensure product quality.

4.1. Visual inspection

Both cellulose and polyurethane sponges adhere to the specifications.

4.2. pH

During the manufacture of sponges, many chemical products are employed. If they are not well removed, they can interfere with the neutralizing solution or broth used in the manufacturing of sampling tools, as they can particularly affect the pH. Thus, the pH of the water release from a wet sponge must be very close to the pH of the water used to soak it, with a ratio close to 1.

Both cellulose and polyurethane sponges present similar conforming results as it can be observed in table 1.

Table 1: Comparison of pH ratio of cellulose and polyurethane sponges

Cellulose sponges		Polyurethane sponges	
Lot	pH (ratio)	Lot	pH (ratio)
2019-009	0.97	2019-030	1.04
2018-107	0.89	2018-134	1.03
2018-100	0.94		

Acceptance criteria: 0.89 – 1.10

4.3. Bioburden

Hygiena’s sponge manufacturer follows the international standard ISO 11137 to guarantee product sterility. The bioburden information is used to set the irradiation dose. As a consequence, the bioburden of the finished product and all its components must be controlled to avoid compromising irradiation effectiveness.

Table 2: Comparison of bioburden of cellulose and polyurethane sponges

Cellulose sponges			Polyurethane sponges		
Lot	Microorganism (Av.)	Fungi (Av.)	Lot	Microorganism (Av.)	Fungi (Av.)
2019-009	165	0	2019-030	40	0
2018-107	26	0.4	2018-134	18	0
2018-100	98	0.4			

Av.: Average. • Bioburden acceptance criteria: average: 2 fungi per sponge and average: 200 CFU per sponge.

Sterilization by gamma irradiation is therefore strong enough to overcome these levels of bioburden of both the cellulose and polyurethane sponges as shown in Table 2.

4.4. Performance

As explained before, during the manufacture of sponges, many chemical products are employed. If they are not well removed, they can be liberated in the neutralizing solution or broth used in the composition of the sampling tool. These chemicals can affect the pH of the solution and they can also have a biocide or bacteriostatic effect. For this reason, each batch of sponge is verified using a method which mimics their usage.

During the performance of this test, it was observed that polyurethane sponges soaked with DE broth presented a variable color, in comparison with cellulose sponge. However, both types performed equivalently in Table 3.

Table 3: Comparison of performance of cellulose and polyurethane sponges

Cellulose sponges				Polyurethane sponges			
Lot	Exc. (%)	Sat. (%)	Fail (%)	Lot	Exc. (%)	Sat. (%)	Fail (%)
2019-009	73.3	26.7	0	2019-030	100	0	0
2018-107	100	0	0	2018-134	100	0	0
2018-100	100	0	0				

Exc.: Excellent; Sat: Satisfactory;
Acceptance criteria: Not more of 3.12% of samples can fail.

5. Conclusion

All tests implicating the functionality of both the cellulose and polyurethane sponges present satisfactory and similar results. In consequence we can affirm that both types offer a similar and adequate performance.